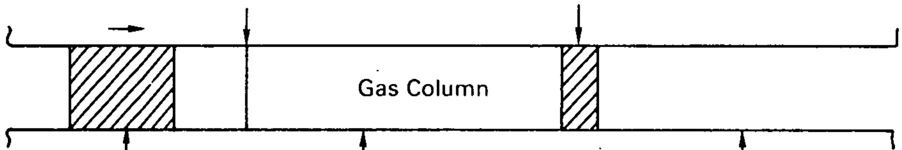
NASA TECH BRIEF

Advances in Light-Gas Gun Technology



Light-gas (hydrogen or helium) guns have been in use for accelerating small projectiles or test specimens to hypervelocities. The approximate practical performance limit of (two-stage) light-gas guns in common use has been 30,000 feet per second. To simulate the effects of micrometeoroid interaction with spacecraft structures, it is essential to accelerate projectiles (particles) weighing from 10^{-2} to 10^{-5} gram to velocities up to 50,000 feet per second. As the light-gas gun provides an intact, discrete projectile of known mass, material, and geometry required for studying the micrometeoroid impact process in detail, a theoretical and experimental investigation was conducted to extend the capability of a conventional light-gas gun at a NASA facility.

One of the principal results of the investigation has been the development of a disposable accelerator on the muzzle of the light-gas gun. The accelerator operates on gas dynamic principles. It uses the energy and momentum of a primary projectile, launched by the light-gas gun, to achieve high velocities of a relatively light secondary projectile accelerated from rest in the accelerator. The internal cross sectional area of the accelerator is constant and identical to that of the light-gas gun barrel.

The design principle of the constant-area accelerator is shown in the schematic diagram. Initially, the column of gas in the compression tube is at rest. A high-velocity primary projectile from the gas gun fractures the diaphragm and enters the compression tube where it loses energy to the gas, causing it to accelerate. Increased gas pressures force the low-mass secondary projectile to accelerate down the launch tube. This exchange of energy and momentum continues up to the point where there is no significant decrease in the velocity of the primary projectile or increase in the velocity of the secondary projectile.

The theoretical investigation indicated that secondary velocities which were 60 to 80 percent higher than the primary velocity could be achieved for primary-to-secondary projectile mass ratios of 20 or greater. Such increases were found to be independent of primary velocity, if losses are neglected. Experimental firings gave good agreement with theory. Secondary velocities were 45 to 60 percent higher than primary velocities for a projectile mass ratio of 18. There was little tendency for the percentage increases to fall off with increasing primary velocity, indicating that energy-loss effects were not severely limiting the accelerator performance.

(continued overleaf)

Secondary velocities of over 30,000 feet per second were achieved from primary velocities slightly under 20,000 feet per second. The secondary velocities were found to be limited by anomalous failures of the disk-like metal secondary projectiles which were employed. These failures prevented the investigation of projectile mass ratios above 18 and limited the secondary velocity of the accelerator configuration.

Note:

Complete details may be obtained from:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
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Patent status:

No patent action is contemplated by NASA.

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